A nonlinear wave-wave coupling process as a generation mechanism of the second harmonic radiation of the planetary radio emissions

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In the spectra of terrestrial hectometric radiation (THR) observed by the Akebono satellite, intense discrete components have been frequently observed in two frequency bands, from 1.3MHz to 2.1 MHz (1.7MHz band) and from 2.6MHz to 4.2MHz (3.4MHz band) forming a harmonic relation in the frequency range. Polarization measurements of these emissions have shown that the fundamental emission shows the nature of the L-O mode wave and the second harmonic emission reveals the nature of the R-X mode wave. The same polarization characteristics have been found in the case of auroral kilometric radiation (AKR) (Oya, 1990) and kilometric radiation in the plasmasphere; suggesting that there is a common generation mechanism of these radio emissions. The polarization feature of the fundamental and the second harmonic radiation can be understood by the linear and nonlinear mode conversion processes from UHR mode waves into L-O and R-X mode electromagnetic waves. The UHR mode waves generated by the kinetic instabilities in a plasma are converted into L-O mode electromagnetic waves through the linear mode conversion process and observed as the fundamental emission. The origin of the second harmonic radiation includes the nonlinear wave-wave coupling processes of excited UHR mode waves to produce R-X mode electromagnetic waves.

A theoretical estimation of the energy conversion rates from UHR mode waves into R-X and L-O mode waves have shown that R-X mode waves are typically 20dB stronger than L-O mode waves; that is in good agreement with the observations. For the efficient nonlinear mode conversion, i.e., for the coherent wave-wave interaction, the band width of the initial UHR mode wave is an important factor. The UHR mode waves tend to concentrate their energy in a narrow frequency range close to the local UHR frequency while propagating in an inhomogeneous plasma where beam plasma driven instabilities take place. This propagation nature of UHR mode waves can be an origin of the coherent nonlinear mode conversion process.